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Report on Tests
of

Model DK Direction Finder Receiver
to Determine Signal-Noise Characteristics
and Make Recommendations as to Any Corrective Action
Required on Model DK Receivers in
the Service

FR-1386

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AUTHORIZATION FOR TEST

1. The tests herein reported were authorized by reference (a). Other pertinent data are listed as references (b) and (c) inclusive.

Reference: (a) BuEng. ltr. NX19/S67(5-15-W8) of 13 July 1936.
(b) Comdt. Navy Yard Norfolk ltr. NX19/S67(46-MOR) of 15 May 1936.
(c) NRL 2nd end. S67/69 of 30 June 1936.

OBJECT OF TEST

2. The object of these tests is to determine the operating condition and characteristics of a Model DK direction finder receiver as furnished by Washington Navy Yard for use in making such tests, particularly with respect to the signal noise ratio; also to investigate the characteristics as affected by certain modifications to the receiver, which are described in reference (b) and to make recommendations as to any corrective action that should be taken with respect to all Model DK direction finders in the Service.

ABSTRACT OF TEST

3. The receiver was first given a mechanical inspection, after which the following tests were made:

- (a) Sensitivity, as received.
- (b) Maximum noise, as received.
- (c) Sensitivity, after repairs and realignment.
- (d) Maximum noise, after repairs and realignment.
- (e) Sensitivity, with one stage of audio cut out.
- (f) Maximum noise, with one stage of audio cut out.
- (g) Sensitivity test comparable with test 3, paragraph 9 of reference (b).

Conclusions

(a) In the tests made by this Laboratory, better sensitivities are shown with the Model DK receiver operating in its normal condition, with two stages of audio amplification.

(b) The tests made by Norfolk Yard, as in paragraph 9 of reference (b), which show better sensitivity with one stage of audio, with increased volume control settings, are confirmed by the tests made here. The conditions under which this test was made, however, do not exist when the receiver is in actual service. The use of only one stage of audio necessitates increasing the gain of the r.f. and i.f. stages to a point where operation becomes unstable due to interaction between the circuits.

(c) While the maximum noise is greatly reduced by the elimination of one stage of audio, better usable sensitivity is maintained with two stages of audio amplification. The change to one stage of audio is, therefore, not considered desirable.

Recommendations

(a) No recommendations are made with respect to any corrective action which should be taken in connection with all Model DK direction finders in the Service, as it is believed that the best results may be obtained with the existing circuits, when the i.f. circuits are properly aligned, and the tubes effectively neutralized.

MATERIAL UNDER TEST

4. One Model DK direction finder receiver, Type OAY-3866, Serial No. W69, received at the Naval Research Laboratory on 16 July 1936 from Washington Navy Yard.

METHOD OF TEST

5. For sensitivity measurements, the voltage output of a Model LN signal generator was fed to the center of a loop through a 100 to 1 padding cable, the resistance in series with the loop being 0.5 ohm. The loop used was made up of two coils of litz wire, having a total inductance of 108.5 microhenries approximating the value normally used with the Model DK. Outputs were measured with a 20,000 ohm rectifier type output meter.

6. Lead cell batteries were used for both filament and plate voltage supply. The volume control rotates through an arc of 300° and the settings are indicated by the angular degrees of rotation from minimum or zero. All sensitivity measurements were for a standard output of 6 milliwatts with a gain adjustment for a noise level of 60 microwatts, and were taken with a CW input and with the r.f. plate tuning "in".

DATA RECORDED

7. The data obtained during the test are recorded in Tables 1 and 2 and Plates 1 and 2 appended hereto.

PROBABLE ERRORS IN RESULTS

8. The estimated overall accuracy for the tests made is as follows:

Sensitivity	± 20% (actual)	± 10% (relative)
Maximum noise level	± 10%	

In using the padding cable with the Model LN signal generator, a resistance of 50 ohms is placed across the output of the signal generator, the output impedance of which is 10 ohms. This places somewhat of a load on the output and the microvolts input for sensitivity measurements are actually lower than the dial readings recorded.

RESULTS OF TESTS

9. Two type 38032 tubes only were received with the equipment, one of which was burned out. Tubes were supplied by this Laboratory and sensitivity measurement was made with the receiver in the condition in which it was received in all other respects. Plate 1 shows the sensitivity and maximum noise level for this condition. Table 1 shows the volume control setting for each frequency.

10. Realignment of the intermediate frequency stages and neutralization of the tubes was then undertaken to determine the extent to which their adjustment as then existing contributed to the comparatively low noise level found during the first measurements of sensitivity. Upon attempting to realign the second stage of i.f., it was found that resonance could not be obtained. In-

investigation showed that a winding was open in the i.f. transformer for this stage. When repairs were made, satisfactory resonance was obtained, and the realignment and neutralization completed, sensitivity measurements were then made and the results with maximum noise levels are shown on Plate 2. Volume control settings for each frequency are shown on Table 1. It will be noted that while the sensitivities are no greater for some frequencies, they are leveled off throughout all bands, and they are obtained with greatly reduced volume control settings. This is due to the fact that the maximum noise level is greatly increased throughout. Sensitivity was then taken with one stage of audio and is shown also on Plate 2. This shows the sensitivity to be reduced as compared with that for two stages of audio and that the maximum noise level is reduced. Volume control settings are at or near maximum for all frequencies, and are shown on Table 1.

11. Sensitivity measurements were then made under conditions comparable with test 3, paragraph 9 of reference (b), with both one and two stages of audio, and the results, together with volume control settings and noise level adjustments are shown in Table 2. The input was applied across the receiver loop terminals through the regular LN signal generator cable without pad, and the loop tuning condenser was set for minimum capacity.

12. With the input voltage applied in this manner, results are obtained which show better sensitivity with one stage of audio than with two stages, as found in the tests made by the Norfolk Yard. To obtain these sensitivities, however, it is necessary to operate with the volume control at or near maximum setting, which causes excessive reaction between stages, and makes the receiver very difficult to tune. The actual sensitivities obtained with the input voltage applied to the loop terminals, however, are not nearly as good as those obtained with the receiver operating under normal conditions; i.e., with the voltage pick up in the loop, and the center of the loop grounded. When a ground is placed on one of the loop terminals in this particular test, the sensitivity relation of the one and two stages audio conditions returns to normal. Under the conditions of this test, the first tuned circuit is replaced by an aperiodic circuit, which adversely affects the overall Q, and the Q and selectivity of the following circuits are affected by virtue of the increased volume control setting which lowers the plate impedance shunting such circuits. This does not appear to be a fair representation of the results which may be expected with the loop replaced, as under actual operating conditions.

CONCLUSIONS

13. In the tests made by this Laboratory, better sensitivities are shown with the Model DK receiver operating in its normal condition, with two stages of audio amplification.

14. The tests made by Norfolk Yard, as in paragraph 9 of reference (b), which show better sensitivity with one stage of audio, with increased volume control settings, are confirmed by the tests made here. The conditions under which this test was made, however, do not exist when the receiver is in actual service. The use of only one stage of audio necessitates increasing the gain of the r.f. and i.f. stages to a point where operation becomes unstable due to interaction between the circuits.

15. While the maximum noise is greatly reduced by the elimination of one stage of audio, better usable sensitivity is maintained with two stages of audio amplification. The change to one stage of audio is, therefore, not considered desirable.

TABLE 1

Volume Control Settings for Sensitivity Measurements
and Maximum Noise

<u>Freq. kc</u>	<u>Before Alignment</u>		<u>After alignment two stages audio</u>		<u>After alignment one stage audio</u>	
	<u>VC</u>	<u>Noise v</u>	<u>VC for 1.1 v</u>	<u>Noise v</u>	<u>VC</u>	<u>Noise v</u>
100	300	1.	108	18	300	.65
140	220(1.1v)	2.	105	20	255(1.1v)	1.2
180	170(1.1v)	3.2	103	21	240(1.1v)	1.32
220	165(1.1v)	4.0	99	22	217(1.1v)	1.65
250	160(1.1v)	4.5	95	23	215(1.1v)	1.70
250	300	.45	150	8	300	.2
320	300	.6	126	11	300	.3
380	300	.72	122	12	300	.35
440	300	.98	115	14	300	.42
515	300	.75	125	11.5	300	.2
515	300	.2	156	5.	300	.1
625	300	.8	153	5.5	300	.15
750	300	1.	136	8	300	.2
875	210(1.1v)	1.9	120	11	300	.3
1000	300	.9	105	14	300	.3

TABLE 2

Sensitivity and Volume Control Settings

For Various Noise Level Adjustments.

Input Across Receiver Loop Terminals.

Test Comparable with Test 3, Par. 9 of ref.(b).

<u>Freq.</u>	<u>μv input for 6 mw output</u>	<u>VC degrees</u>	<u>Noise level Adjustment</u>	<u>No. of audio stages</u>
180	215	106	.5	2
	45	122	1.1	2
	10	103	1.1*	2
	26	130	1.5	2
	18	138	2.	2
380	520	116	.5	2
	160	100	.2*	2
	69	150	1.1	2
	40	160	1.5	2
	27	170	2.	2
750	340	115	.5	2
	38	103	.4*	2
	39	150	1.1	2
	24	157	1.5	2
	15	166	2.	2
180	48	190	.5	1
	22	250	1.1	1
	25	230	1.1*	1
380	**200	300	Negligible	1
	**400	300	.2*	1
750	**190	300	.25	1
	**110	300	.4*	1

* With signal generator across (grid) loop terminal and receiver ground.

** Very unstable when operating with maximum volume control settings.

MODEL DK RECEIVER
 SERIAL W 69
 SENSITIVITY-AFTER REPAIRS & REALIGNMENT

TWO STAGES AUDIO ONE STAGE AUDIO

